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Nekton Use of Salt Marshes of the Southeast Region of the United States

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Abstract

Published studies of nekton in salt marshes of the Southeast Region of the U.S. were reviewed to identify fish and decapod crustaceans associated with marsh-surface habitats, to describe preferred microhabitats, and to compare habitat use between the Gulf of Mexico and Atlantic coasts. Nekton assemblages are dominated by estuarine resident species such as daggerblade grass shrimp *Palaemonetes pugio*, sheepshead minnow *Cyprinodon variegatus*, and several other cyprinodonts. Other numerically dominant cyprinodonts are: gulf killifish *Fundulus grandis* and diamond killifish *Adinia xenica* on the Gulf coast and mummichog *F. heteroclitus*, spotfin killifish *F. luciae*, and striped killifish *F. majalis* on the Atlantic coast. Most resident species can use interior marshes that are remote from subtidal habitats. The majority of estuarine transients, including many fishery species (e.g., spotted seatrout *Cynoscion nebulosus* and brown shrimp *Penaeus aztecus*), select marsh edge, that part of the marsh surface immediately adjacent to subtidal habitats. Marsh submergence time also influences habitat selection. Nekton assemblages using the marsh surface along the Atlantic and Gulf coasts differ not only in terms of species composition, but also by nekton densities. Densities on Gulf coast marshes are at least an order of magnitude greater than those reported from Atlantic coast marshes. Differences in habitat utilization may be due to dissimilarities in marsh geomorphology, tidal regimes, or rates of relative sea level rise along the two coasts.

Introduction

Estuaries of the Southeast Region of the United States support important commercial fisheries by providing essential habitat for the young of exploited species. Recognition of this estuarine dependency for most commercial species in the region led to numerous studies of estuarine habitats. However, most were investigations of open-water habitats deep enough to sample using a trawl towed

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from a small boat. Until recently, examinations of tidal marsh habitats were hampered by the lack of quantitative sampling gear, and therefore, direct use of the marsh surface by fishery species was not recognized (Boesch and Turner 1984).

The recent development of innovative methods for sampling tidal marshes made it possible to obtain quantitative estimates of nekton densities in marsh-surface habitats (Zimmerman and Minello 1984, McIvor and Odum 1986, Kneib 1991, Rozas 1992b). Over the last decade, investigations of marsh-surface habitats have encompassed a range of salinity regimes and geographic regions, and fishes and decapods were found to directly use the marsh surface in all studies conducted thus far (Zimmerman and Minello 1984, Rozas and Odum 1987, McIvor and Odum 1988, Hettler 1989, Murphy 1991).

Most research in this area has focused on the salt marshes of the southeastern U.S., and the number of such studies is now adequate to make some general observations about marsh habitat utilization in this region. The goals of this paper were to identify the nekton species found in salt marshes of the Southeast Region that use marsh-surface habitats, to describe preferred microhabitats of dominant species, and to compare habitat use between the Gulf of Mexico and Atlantic coasts.

Habitat Description

Salt marshes of the southeast region of the U.S. are dominated by *Spartina alterniflora* and occur in all the Gulf of Mexico and south Atlantic coastal states. Other species sometimes associated with *Spartina alterniflora* in salt marshes are *Juncus roemerianus*, *Distichlis spicata*, and *Spartina patens*. Salt marshes are most extensive on the Gulf coast in the Mississippi River deltaic plain of Louisiana and on the Atlantic coast bordering the estuaries of Georgia and South Carolina. These marshes are usually flooded by tidal waters, and are therefore accessible to aquatic species, once or twice daily for several hours at a time.

Methods

A list of nekton associated with marsh-surface habitats was compiled by reviewing published studies of salt marshes of the Southeast Region of the U.S. In each study, species were ranked in order of abundance within two major faunal groups (fishes and decapod crustaceans).

Most ranked species were assigned to habitat-use categories using information from Peterson and Turner (1993). However, species that were not abundant in their study were classified by comparing their relative abundance when collected using different sampling gear as described below. Peterson and Turner (1993) describe four patterns of marsh utilization, but I combined their A and B categories and assigned species to three categories as follows. "Edge species" (Peterson and Turner's Category C) use the vegetated marsh surface, but they seldom penetrate more than a few meters into the marsh from a channel, embayment or other subtidal refuge. Therefore, organisms were classified as edge species when they were abundant in samples taken with flumes, block nets, or drop samplers (which sample marsh edge habitat) but were seldom collected in lift nets or flume weirs located in the marsh interior. "Interior species" (Peterson and Turner's Categories A and B) are not restricted to marshes near open water; they penetrate deeply into the marsh interior when it is flooded and retreat to subtidal areas on the marsh surface (Category A) or in major waterways (Category B) when the marsh drains. Organisms were called interior species if they were abundant in lift net or flume-weir samples collected away from the marsh edge. Open-water, schooling organisms were placed into the "peripheral species" category (Peterson and Turner's Category D). These organisms may use shallow areas along the marsh-open water interface, but they seldom use the vegetated marsh surface. However, peripheral species may be numerically important in samples taken at the marsh edge (e.g., in studies using flumes and drop samplers).

Results and Discussion

Fifty-one species in 24 families of fishes and seven species in three families of decapods have been collected in marsh-surface habitats of the southeast region of the U.S. (Table 1). The families Cyprinodontidae, Gobiidae, Sciaenidae, Palaemonidae, and Penaeidae contributed the most species to marsh-surface assemblages. Assemblages were composed mostly of the young and adults of estuarine resident species and small juveniles of estuarine transients (Zimmerman and Minello 1984, Hettler 1989, Rozas 1992a).

Although numerous species use the marsh surface to some extent, the degree of habitat use varies among species. Daggerblade grass shrimp *Palaemonetes pugio*, sheepshead minnow *Cyprinodon variegatus*, and several other species of cyprinodonts were among the most abundant organisms collected in marsh-surface habitats along both coasts (Table 1). Other numerically dominant cyprinodonts were: Gulf killifish *Fundulus grandis* and diamond killifish *Adinia xenica* on the Gulf coast and mummichog *F. heteroclitus*, spotfin killifish *F. luciae*, and striped killifish *F. majalis* on the Atlantic coast. Other fishes commonly collected on the marsh surface were bayou killifish *F. pulvereus*, sailfin molly *Poecilia latipinna*, inland silverside *Menidia beryllina*, pinfish *Lagodon rhomboides*, spotted seatrout *Cynoscion nebulosus*, striped mullet *Mugil cephalus*, darter goby *Gobionellus boleosoma*, and naked goby *Gobiosoma bosc*. Decapod crustaceans using the marsh surface, and following daggerblade grass shrimp in abundance, were brown shrimp *Penaeus aztecus*, white shrimp *Penaeus setiferus*, and blue crab *Callinectes sapidus*. In contrast to these species, some of the most numerous fishes of Gulf and Atlantic coast estuaries were uncommon or rare in marsh-surface habitats. For example, bay anchovy *Anchoa mitchilli*, menhaden *Brevoortia* spp., Atlantic croaker *Micropogonias undulatus*, and sand seatrout *Cynoscion arenarius* dominate the fish assemblages of open-water habitats in estuaries of the southeastern U.S. (Dahlberg 1972, Sheridan 1983, Deegan and Thompson 1985, Ross and Epperly 1985), but they were much less abundant or absent from studies of marsh-surface habitats (Table 1). They were common only in studies employing drop samplers or flumes in which samples were collected at the marsh-open water interface where these species may occur at high tide (Peterson and Turner 1993).

Nekton species may be influenced in their choice of specific marsh-surface habitats by at least two factors: (1) proximity to subtidal habitat (Zimmerman and Minello 1984, Peterson and Turner 1993) and (2) submergence time (Zimmerman

Table 1. A partial list of fishes and decapod crustaceans collected on the marsh surface along the northern Gulf of Mexico and south Atlantic coasts of the U.S. Numbers below each region refer to the following studies, locations, and sampling gears: (1) Zimmerman et al. 1990a (Galveston Bay, Texas; drop sampler), (2) Zimmerman et al. 1990b (Lavaca Bay, Texas; drop sampler), (3) Rozas 1992a (Terrebonne Bay, Louisiana; flume net), (4) Rozas 1992b (Terrebonne Bay, Louisiana; lift net), (5) Peterson and Turner 1993 (Terrebonne Bay, Louisiana; flume net), (6) Hettler 1989 (Newport River estuary, North Carolina; block net), (7) Kneib 1991 (Duplin River, Georgia; flume weir). The rank by number is given for numerically dominant species in each study that account for >1% of the total fish or decapod catch (x=collected, but represents ≤1% of catch). Species collected only rarely in a single study are not listed. Habitat categories (HC) are: e=edge, i=interior, and p=peripheral.

	STUDY							
Scientific and common name	Gulf of Mexico					S. Atlantic		
	1	2	3	4	5	6	7	HC
Fishes								
Elopidae								
Elops saurus ladyfish			x				x	
Ophichthidae								
Myrophis punctatus speckled worm eel	8		x	x	x			e
Clupeidae								
Brevoortia patronus gulf menhaden			6					p
Brevoortia tyrannus Atlantic menhaden							x	
Engraulidae								
Anchoa mitchilli bay anchovy	x	7	12	x		10		p
Synodontidae								
Synodus foetens inshore lizardfish						x		
Batrachoididae								
Opsanus beta gulf toadfish	x		x		x			
Opsanus tau oyster toadfish						x		
Cyprinodontidae								
Adinia xenica diamond killifish	x	x	2	3	3			i
Cyprinodon variegatus sheepshead minnow	5	x	3	2	8	4	x	i
Fundulus grandis gulf killifish	4	5	1	1	2			i

Table 1 (Cont.).

	STUDY							
Scientific and common name	Gulf of Mexico					S. Atlantic		
	1	2	3	4	5	6	7	HC
Fundulus heteroclitus mummichog						1	1	i
Fundulus jenkinsi saltmarsh topminnow			11	x	9			e
Fundulus luciae spotfin killifish							2	i
Fundulus majalis striped killifish						3	6	i
Fundulus pulvereus bayou killifish	x		8	6	4			i
Fundulus similis longnose killifish	x		x	7				i
Lucania parva rainwater killifish	x		x	x	7			i
Poeciliidae								
Poecilia latipinna sailfin molly			9	x	6		5	i
Atherinidae								
Menidia beryllina inland silverside	6	10	5	5	10			e
Menidia menidia Atlantic silverside						7	x	e
Syngnathidae								
Syngnathus scovelli gulf pipefish	11	9	x		x			e
Syngnathus louisianae chain pipefish	x	12	x			x		e
Centropomidae								
Centropomus undecimalis common snook							x	
Lutjanidae								
Lutjanus griseus gray snapper				x		x		
Gerreidae								
Eucinostomus argenteus spotfin mojarra		x		x		5	x	e
Eucinostomus gula silver jenny						x		
Haemulidae								
Orthopristis chrysoptera pigfish		x				x		

Table 1 (Cont.).

Scientific and common name	Gulf of Mexico 1	2	3	4	5	S. Atlantic 6	7	HC
Sparidae								
Archosargus probatocephalus		x	x	x	x	x		
sheepshead								
Lagodon rhomboides	3	4	x	x	x	8		e
pinfish								
Sciaenidae								
Bairdiella chrysoura		3	7	x	x	x	x	e
silver perch								
Cynoscion nebulosus	10	8	13	x	11	x	x	e
spotted seatrout								
Leiostomus xanthurus		x	x			2	4	p_G/i_A
spot								
Micropogonias undulatus	x	x	x		x			
Atlantic croaker								
Pogonias cromis			x				x	
black drum								
Sciaenops ocellatus	x		x	x	x	x	x	
red drum								
Mugilidae								
Mugil spp.							3	i
Mugil cephalus	9	11	10	4	12	9		i
striped mullet								
Mugil curema						6		
white mullet								
Sphyraenidae								
Sphyraena barracuda						x		
great barracuda								
Blenniidae								
Chasmodes bosquianus						x		
striped blenny								
Eleotridae								
Dormitator maculatus			x	x				
fat sleeper								
Gobiidae								
Evorthodus lyricus			x	x		x	x	
lyre goby								
Gobionellus boleosoma	2	2		x	5	11	x	e
darter goby								
Gobionellus shufeldti			x	x	x			
freshwater goby								
Gobionellus smaragdus							x	
emerald goby								

Table 1 (Cont.).

Scientific and common name	Gulf of Mexico 1	2	3	4	5	S. Atlantic 6	7	HC
Gobiosoma bosc	1	1	4	8	1	x		e
naked goby								
Paralichthyidae								
Citharichthys spilopterus			x	x	x			
bay whiff								
Paralichthys dentatus						x		
summer flounder								
Paralichthys lethostigma	x	13	x		x	x		e
southern flounder								
Achiridae								
Achirus lineatus		x	x		x			
lined sole								
Cynoglossidae								
Symphurus plagiusa	7	6	x		x	x		e
blackcheek tonguefish								
Decapod crustaceans								
Palaemonidae								
Palaemonetes pugio	1	1	1	1	1	*	1	i
daggerblade grass shrimp								
Palamonetes vulgaris	4	3					x	i
Texas river shrimp								
Palamonetes intermedius	7	7						i
brackish grass shrimp								
Penaeidae								
Penaeus spp.						1		
Penaeus aztecus	3	2	3	3	4	*		e
brown shrimp								
Penaeus duorarum	6	6				*		e
pink shrimp								
Penaeus setiferus	5	5	4	4	3	*	2	e_G/i_A
white shrimp								
Portunidae								
Callinectes sapidus	2	4	2	2	2	2	x	i
blue crab								

* = Hettler (1989) identified penaeids to genus only and did not enumerate grass shrimp.

and Minello 1984, Rozas and Reed 1993). The proximity of a marsh to subtidal habitat is important, because aquatic organisms using the marsh surface are confined to subtidal habitats at low tide (when marshes are not flooded), and there seems to be a limit to the distance some organisms will travel into the marsh from these open-water areas (Peterson and Turner 1993). Species using interior marshes remote from subtidal habitats are mostly estuarine residents in two families, Cyprinodontidae and Palaemonidae (Table 1). These are some of the most abundant species found on the marsh surface. Examples are daggerblade grass shrimp, gulf killifish, mummichog, and sheepshead minnow. Striped mullet and blue crab may be the only estuarine transients that use interior marshes on the Gulf coast (Peterson and Turner 1993, Rozas 1992b), whereas mullet *Mugil* spp., spot *Leiostomus xanthurus*, white shrimp, and blue crab exploit such habitat on the Atlantic coast (Kneib 1991). Most estuarine transients select marsh edge habitat, that part of the marsh surface immediately adjacent to subtidal areas (Peterson and Turner 1993). Spotted seatrout, silver perch *Bairdiella chrysoura*, and naked goby are good examples of edge species. Marshes located far from channels, embayments, or other subtidal refuges are inaccessible to these species (Zimmerman and Minello 1984).

A marsh's submergence time or flooding duration obviously influences its use, because aquatic organisms can occupy the habitat only when it is flooded (Rozas and Reed 1993). Submergence time is affected by several factors including marsh-surface elevation, tidal regime, and meteorological events. However, within the same marsh system, surface elevation has the most influence on flooding duration and habitat availability. In microtidal environments, such as Gulf coast marshes, even small differences in elevation result in substantially different flooding durations and habitat utilization. Rozas and Reed (1993) estimated that low *Spartina* marsh was submerged, and therefore available to nekton, 68% of the time compared with 39% of the time for high *Distichlis* marsh. At high tide, when both habitats were available, penaeid shrimp selected *Spartina* marsh, whereas killifishes were most abundant in *Distichlis* marsh. Submergence time may also mediate marsh exploitation by nekton through its influence on other factors such as prey abundance or vegetation stem density (Rozas and Reed 1993).

Habitat selection and the degree to which nekton exploit marsh-surface habitats may also differ between the Atlantic and Gulf coasts. For example, spot and white shrimp are classified as edge species on the Gulf coast (Peterson and Turner 1993), but they were commonly collected on interior marshes in Georgia (Kneib 1991). Perhaps Georgia marshes, which experience tides of much greater amplitude than Gulf coast marshes, allow greater penetration into the marsh interior by some species because they are more deeply flooded.

Zimmerman et al. (1991) have postulated that aquatic organisms exploit Gulf coast marshes in greater numbers than Atlantic coast marshes because of the differences in tidal marsh geomorphology, tidal regime, and rates of relative sea level rise between the two coasts. Quantitative estimates of nekton densities on Gulf and Atlantic coast marshes are few, but the available data are consistent with the hypothesis of greater marsh utilization on the Gulf coast. For example, densities of dominant species reported by Zimmerman and Minello (1984) and Thomas et al. (1990) in Texas and Rozas (1992b) in Louisiana are one to two orders of magnitude greater than those reported by Mense and Wenner (1989) in South Carolina, Hettler (1989) in North Carolina, and Kneib (1991) and Fitz and Wiegert (1991) in Georgia. Regional comparisons of marsh utilization between Gulf and Atlantic coast marshes using identical quantitative sampling methodology and studies that examine the factors that may influence differences in habitat use are needed to address these issues.

In summary, the vegetated surface of salt marshes is used directly by numerous species of estuarine nekton, although microhabitat selection and the degree of habitat exploitation are species specific. Microhabitat selection appears to be influenced by both the proximity of the marsh to subtidal habitat and submergence time. Although studies evaluating the function of marsh-surface habitats have been conducted, they are limited in geographic scope and confined to only a few species (Minello and Zimmerman 1991). More information is needed about how marshes function in supporting the numerous species associated with this habitat. Future research should include regional comparisons of habitat utilization and studies that elucidate the factors that influence habitat selection.

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